United States Department of the Interior
Geological Survey

The U. S. Geological Survey Coal Quality Data Base (COALQUAL)

by

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Introduction

During the energy crisis of the mid-970s the U.S. Geological Survey (USGS), in cooperation with State Geological Survey's, initiated an ambitious project to create a comprehensive national coal information data base. This data base, known as the National Coal Resources Data System (NCRDS), was to contain information on the quantity and quality of our domestic coal resources.

In the mid-1970s energy independence, synfuels, and in-situ gasification were the hopes for the future. The NCRDS was conceived as an exploration tool to help achieve these aspirations. A major objective was to locate, measure, and characterize all of the Nation's coal resources, without regard to bed thickness, depth, location, or quality. An initial goal of the project was to obtain and characterize at least one sample per coal bed from every geographic quadrangle (approximately 50 sq. miles) underlain by coal.

During the nearly 20 years since its inception the NCRDS's Coal Quality data base has developed into the largest publicly available data base of its kind. The data were used primarily by state Geological Surveys, university researchers, and other federal agencies. Recent legislation has stimulated new and broader interest in the Coal Quality data base. The 1990 Amendments to the Clean Air Act (U.S. Statutes, 1990) cite more than a dozen elements as potential hazardous air pollutants. The Act requires the EPA to conduct a study of the toxic air emissions from coal burning utilities. The Act also requires the EPA to perform a health risk assessment and to recommend new air toxic regulations, if necessary, to protect human health and the environment.

Many of the new users (utilities, coal mining companies, coal industry consultants, environmentalists, state and federal agencies, etc.) of the USGS Coal Quality data base have asked questions about its history, composition, and structure. This report is intended to answer the most common questions and to help orient new users of the Coal Quality data base.

What is the USGS's Coal Quality Data Base?

The USGS Coal Quality data base is an interactive, computerized component of the NCRDS. It contains comprehensive analyses of more than 13,000 samples of coal and associated rocks from every major coalbearing basin and coal bed in the U.S.

The data in the coal quality data base represent analyses of the coal **as it exists in the ground**. The data commonly are presented on an as-received whole-coal basis. Other reporting bases, for example, as-analyzed, dry, ash, mineral-matter-free may be obtained on request.

A data base with nearly 2,000,000 entries is bound to contain some errors. To minimize these errors there has been a concerted effort, during the past three years, to "verify" the data in the Coal Quality data base. Every entry is being checked and rechecked against the original data (field notes, analytical reports, etc.). When possible, the sample collector is asked to verify the geology and location information. If the collector is unavailable for verification, original field notes are consulted. The verification process should be completed in 1995.

An international analog to the domestic data base is being formed. The international data base will contain coal quality information on coal from foreign countries.

Sample Collection and Analytical Protocol

The recommended procedures for collecting samples for analysis and inclusion in the USGS Coal Quality data base are described by Stanton (1989). Detailed information on the geographic location (state, county, longitude and latitude, mine, etc.) and geologic and stratigraphic information (thickness, depth, geologic age, formation, member, bed, etc.) is recorded for each sample.

Coal and associated rock samples are analyzed by the USGS for the concentrations of approximately 75 major-, minor-, and trace-elements, and for the standard coal characteristics by the U.S. Bureau of Mines and contract laboratories using American Society of Testing and Materials standards (ASTM, 1993). The standard coal characteristics include proximate and ultimate analysis, heat content, forms of sulfur, ash-fusion temperatures, free-swelling index, and air-drying loss. Equilibrium moisture, apparent specific gravity, and Hardgrove grindability are determined on selected samples. A total of 136 parameters are determined for each sample. The Appendix contains a description of all 136 parameters.

The USGS sample numbers beginning with 'D' were analyzed using a scheme described by Swanson and Huffman (1976). The sample numbers beginning with 'W' were analyzed according to the flow chart in figure 1. Details of the analytical procedures can be found in Golightly and Simon (1989).

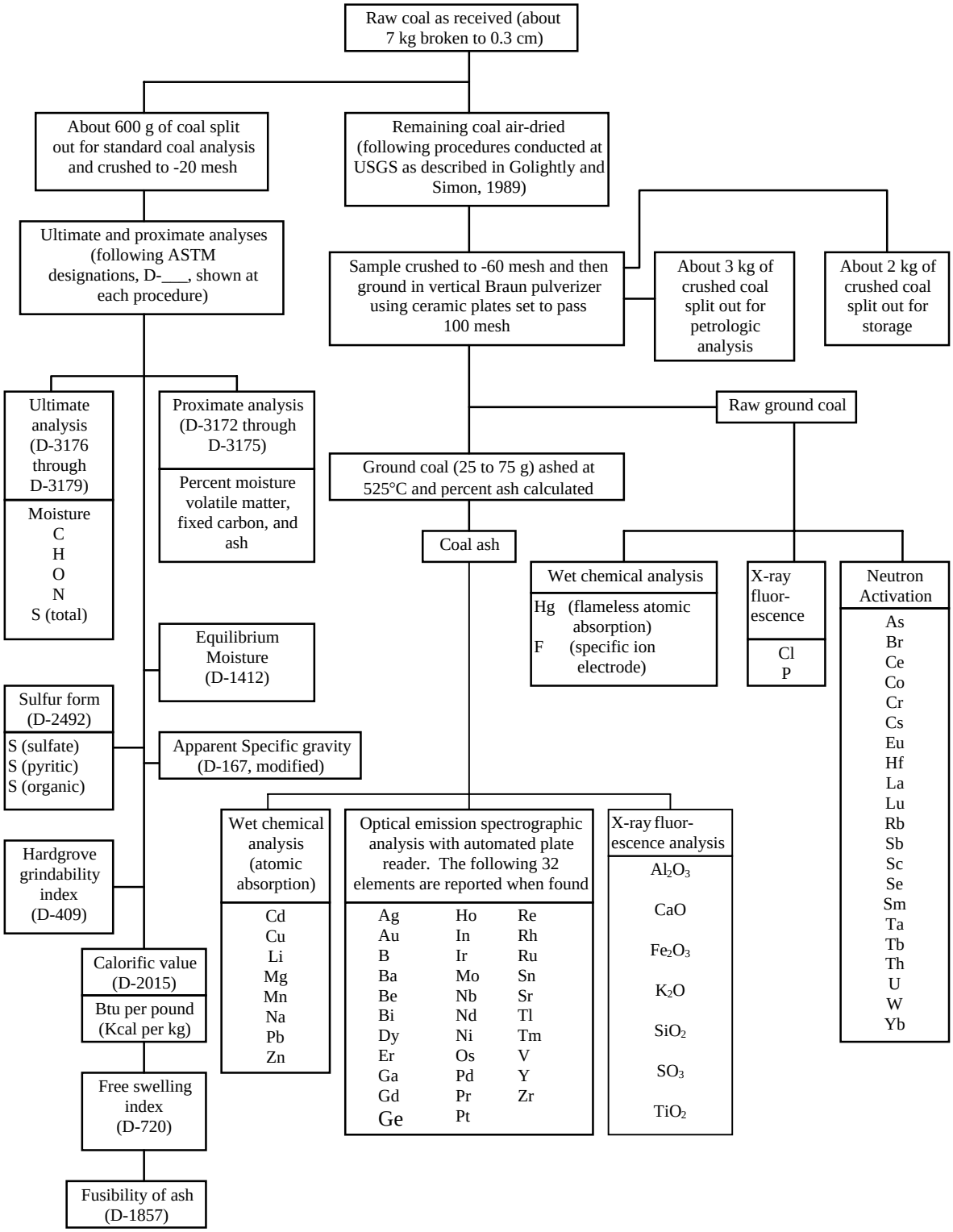

Figure 1. Flow diagram of procedures used through September 1990, for the analysis of coal samples collected. (ASTM-American Society for Testing and Materials, USGS-United States Geological Survey.)

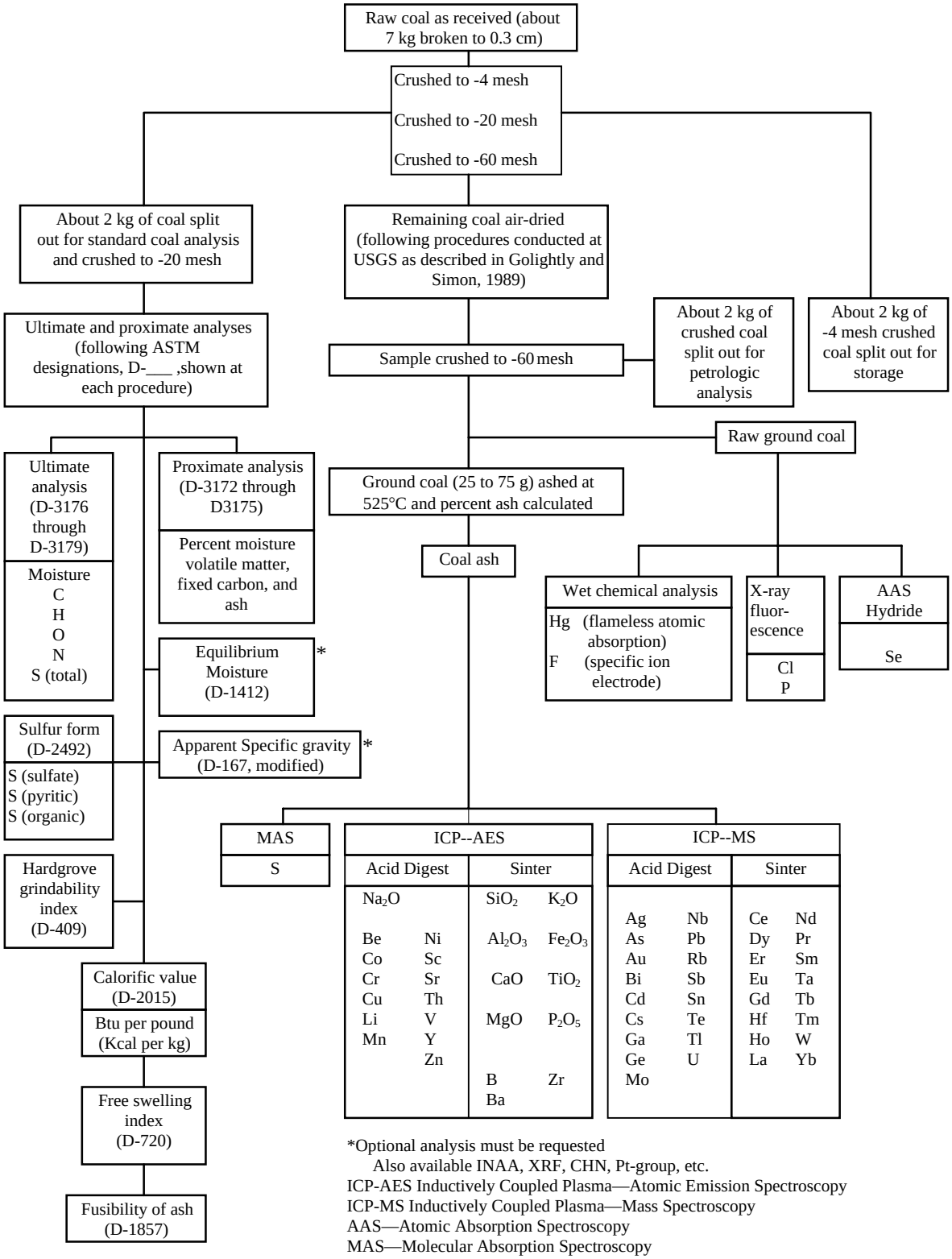

Figure 2. Flow diagram of procedures used after September 1990, for the analysis of coal samples collected. (ASTM-American Society for Testing and Materials, USGS-United States Geological Survey.)

A new analytical scheme for the major- , minor- , and trace-elements has been developed for both 'D' and 'W' samples analyzed after 1990. A flow chart of this scheme appears in Figure 2.

Magnitude of Coal Quality Data Base

The samples collected or submitted for analysis and inclusion in the Coal Quality data base consist primarily of full bed core and channel samples. Some of the bed samples are collected in benches. Analyses of bench samples that need to be composited are weighted by thickness to obtain a calculated analysis of the full coal bed. Where feasible, clastic rocks (partings, overburden, underburden) associated with the coal bed are collected and analyzed. The data base also contains a small number of grab samples, density splits, and other miscellaneous samples; the sample type is recored for all samples in the data base. Table 1 indicates the total number of samples prior to compositing bench samples and the number of samples after compositing bench samples for major coal-bearing areas. Table 2 contains information on the total number of samples, the number of samples after compositing, the number of channel samples, core samples, and miscellaneous samples for each coal-bearing state. Figure 3 illustrates the domestic distribution of analyses in the Coal Quality data base.

Finkelman and others (1991) compiled a bibliography of publications containing element data from the Coal Quality data base. The report includes a compilation of the number of analyzed samples for each state and the number of those analyses that have been published. Approximately one-half of the data in the Coal Quality data base has been reported in publications.

Additions to the Coal Quality data base continue at a reduced level; during the past 5 years approximately 100 analyses have been added annually. The Coal Quality data base is being enhanced by merging it with coal quality data from the Illinois Geological Survey (approximately 700 analyses) and data from the New Mexico Bureau of Mines and Geology (approximately 350 analyses).

Much of the data in the data base was obtained prior to 1982. Consequently, many of the coal samples are from areas that are now mined out or where coal mining subsequently has ceased. The inclusion of these 'dated' samples does not present a problem, however, in using data from the data base for regional projections of coal quality variation.

Vertical and Lateral Distribution of Coal Quality Components

One of the more common uses of the USGS Coal Quality data is to evaluate vertical and lateral distribution of coal quality parameters. Table 3 contains arithmetic means for the potential hazardous air pollutants (U.S. Statutes, 1990) in several coal basins. It is apparent that several elements exhibit a wide range of concentrations among the coal basins. For example, cadmium ranges from 0.1 ppm in the Appalachian basin to 4.2 ppm in the Interior Coal Province (a 4,100 percent variation: ((4.2-.1)/.1)*100). In contrast, mercury ranges from 0.12 ppm in the Powder River basin to 0.22 ppm in the Gulf Coast Province; a variation of 83 percent.

Table 4 contains arithmetic means of the potential hazardous air pollutants in six coal beds within the Appalachian basin. Some elements show a greater variation within the coal basin than among coal basins. For example, mercury has a 183 percent variation among these Appalachian basin samples, and antimony has a 318 percent variation among these samples but only a 163 percent variation among the coal basins in Table 3.

Table 5 contains arithmetic means for the potential air pollutants in six coal samples from the Pittsburgh coal bed from Ohio, Pennsylvania, and West Virginia. In this sample suite arsenic exhibits a 686 percent variation and beryllium has a 397 percent variation; larger variations than exhibited in Tables 3 or 4.

Finally, at bench scale, the smallest sampling scale in the data base, Table 6 shows substantial trace element variations among bench samples from the Pittsburgh coal bed. For example, arsenic shows a 551 percent variation among the bench samples, beryllium a 426 percent variation, cobalt a 608 percent variation, and chromium a 374 percent variation. Mercury exhibits a 480 percent variation among the bench samples; this is almost 6 times larger than its variation among the coal basins (Table 3).

Because trace element variations are as great within beds as they are within and among basins, selective mining may be an option for reducing the concentration of some trace elements in the mined coal. It should be emphasized that the USGS

Figure 3. Distribution of analyses in the U.S. Geological Survey Coal Quality data base.

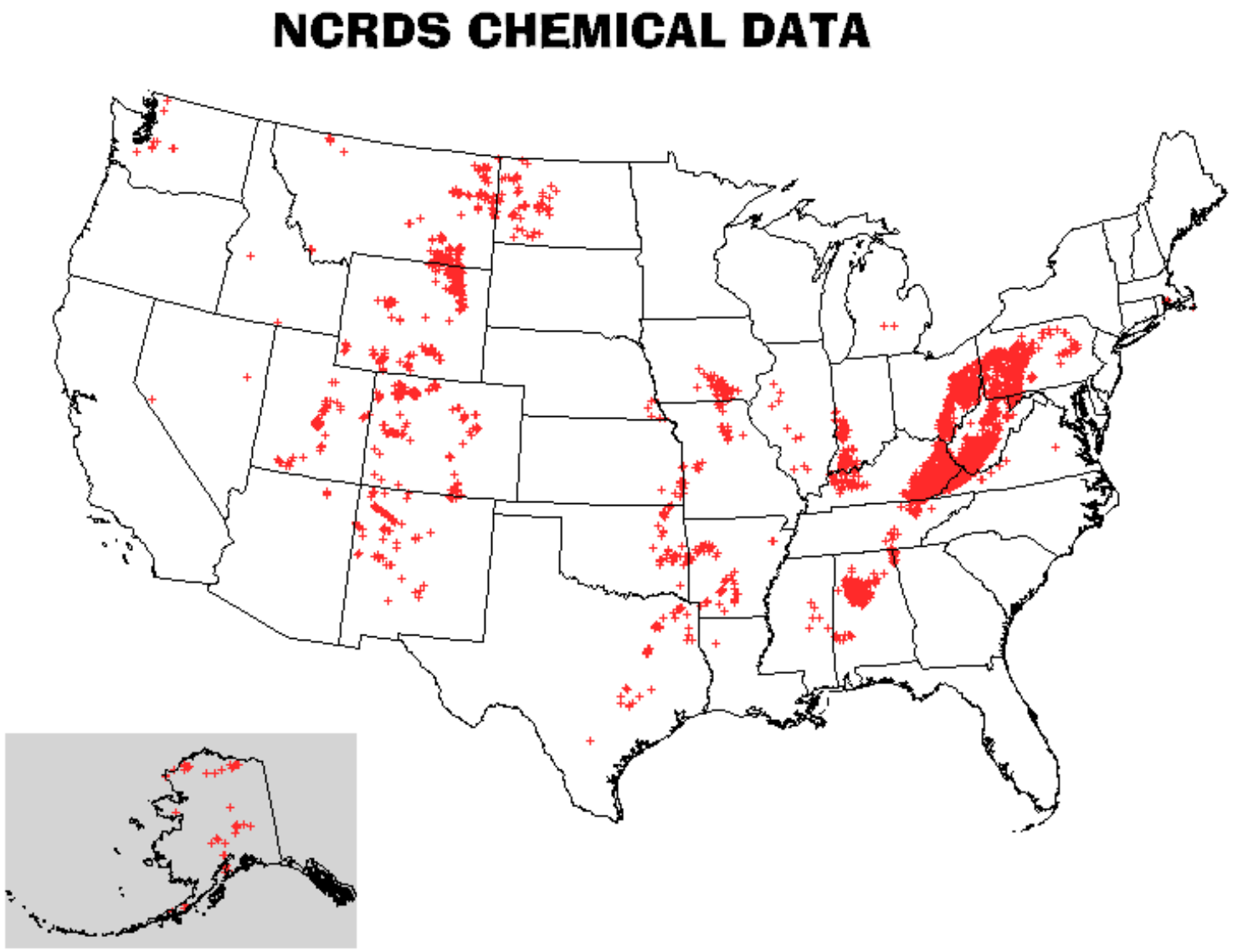

Table 1.--Samples in COALQUAL data base from coal-bearing areas.

Province*	Region**	Total Number of Samples	Total Number of Samples after Compositing
ALASKA	ALASKA PENINSULA	13	8
	CENTRAL ALASKA	259	49
	COOK INLET-SUSITNA	98	30
	NORTHERN ALASKA	296	78
	SEWARD PENINSULA	6	1
EASTERN	ATLANTIC COAST	67	2
	CENTRAL APPALACHIAN	2,198	1,777
	NORTHERN APPALACHIAN	2,627	1,636
	PENNSYLVANIA ANTHRACITE	72	52
	RHODE ISLAND META-ANTHRACITE	18	12
	SOUTHERN APPALACHIAN	1,062	987
GULF	MISSISSIPPI	67	23
	TEXAS	197	118
INTERIOR	EASTERN	826	298
	NORTHERN	10	3
	WESTERN	445	329
NORTHERN GREAT PLAINS	FORT UNION	414	300
	NORTH CENTRAL	12	7
	POWDER RIVER	1,666	612
ROCKY MOUNTAIN	DENVER	123	42
	GREEN RIVER	1,117	416
	HAMS FORK	47	29
	RATON MESA	96	40
	SAN JUAN RIVER	337	193
	SOUTHWESTERN UTAH	63	42
	TERTIARY LAKE BEDS	12	7
	UINTA	614	253
	WIND RIVER	44	42
NO DATA ENTERED	NO DATA ENTERED	229	46
	TOTAL SAMPLES	13,035	7,432

*SOURCE: Cargill and others, 1976, pages 8 and 13.
**SOURCE: Cargill and others, 1976, pages 9 and 13.

Table 2.--Samples in COALQUAL data base from coal-bearing states.

State	Total Number of Samples	Total Number of Bench Samples	Total Number of Coal Composited Bench Samples	Total Number of Coal Samples After Compositing	Total Number of Coal Channel Samples* After Compositing	Total Number of Coal Drill Core Samples* After Compositing	Total Number of Rocks and Miscellaneous Samples removed from raw data base to create COALQUAL data base
ALABAMA	1032	1	-	951	503	448	80
ALASKA	672	466	75	166	145	21	115
ARIZONA	40	27	9	11	11	-	11
ARKANSAS	107	6	-	76	30	46	25
CALIFORNIA	1	-	-	-	-	-	-
COLORADO	952	361	69	372	100	272	288
GEORGIA	39	-	-	37	37	-	2
IDAHO	58	3	-	3	1	2	52
ILLINOIS	133	91	16	16	16	-	42
INDIANA	378	40	16	157	157	-	197
IOWA	145	-	-	118	33	85	27
KANSAS	45	5	1	30	30	-	11
KENTUCKY	1226	57	22	905	712	193	286
LOUISIANA	1	-	-	1	1	-	-
MARYLAND	75	15	4	59	59	-	5
MASSACHUSETTS	12	2	-	4	-	4	6
MICHIGAN	10	-	-	3	3	-	7
MISSISSIPPI	31	14	2	9	7	2	10
MISSOURI	138	41	20	91	78	13	26
MONTANA	893	483	126	360	61	299	176
NEBRASKA	17	-	-	6	6	-	11
NEVADA	14	1	-	2	2	-	11
NEW MEXICO	343	73	19	191	54	137	98
NORTH CAROLINA	55	-	-	-	-	-	55
NORTH DAKOTA	273	41	15	205	33	172	42
OHIO	805	211	75	660	468	192	9
OKLAHOMA	85	47	19	56	45	11	1
PENNSYLVANIA	1593	645	184	809	615	194	323
RHODE ISLAND	11	-	-	9	-	9	2
TENNESSEE	62	-	-	58	58	-	4
TEXAS	128	39	12	73	28	45	28
UTAH	486	176	15	173	55	118	152
VIRGINIA	585	72	30	493	414	79	50
WASHINGTON	80	43	1	14	14	-	24
WEST VIRGINIA	887	192	51	617	594	23	129
WYOMING	1623	584	125	697	183	514	467
	13035	3737	906	7432	4553	2879	2772

*Full bed samples in COALQUAL database.

Table 3.--Comparison of potential air toxics among coal basins.

(Values are arithmetic means in parts-per-million on a whole-coal basis, except for number of samples.)

Element	Appalachian basin	Interior Province	Gulf Coast lignites	Fort Union lignites	Powder River basin
Antimony	1.4	1.5	1.0	0.69	0.57
Arsenic	35.0	20.0	10.0	11.0	5.6
Beryllium	2.5	2.4	2.4	1.0	0.84
Cadmium	0.1	4.2	0.55	0.16	0.16
Chromium	17.0	19.0	24.0	6.4	8.5
Cobalt	7.2	10.0	7.2	2.4	2.3
Lead	8.4	40.0	21.0	4.8	5.5
Manganese	29.0	78.0	150.0	83.0	63.0
Mercury	0.21	0.15	0.22	0.14	0.12
Nickel	17.0	27.0	13.0	4.1	6.4
Selenium	3.5	3.2	5.7	0.82	1.1
Uranium	1.7	3.1	23.0	1.8	1.6
Number of Samples	4700	800	200	350	800

Table 4.--Comparisons of potential air toxics among coal beds in the Appalachian basin.

(Values are arithmetic means in parts-per-million on a whole coal basis, except for number of samples.)

Element	Meigs Creek coal bed	Redstone coal bed	Pittsburgh coal bed	Lower Freeport coal bed	Lower Kittanning coal bed	Sewell coal bed
Antimony	0.3	0.7	0.6	1.2	0.9	1.1
Arsenic	6.7	29.1	20.4	37.3	25.2	11.1
Beryllium	1.4	1.6	1.4	2.7	2.6	2.2
Cadmium	0.08	0.07	0.11	0.11	0.14	0.10
Chromium	16.4	13.8	14.7	17.4	16.8	11.8
Cobalt	3.2	3.5	4.6	7.6	6.7	8.0
Lead	5.3	4.0	4.9	10.4	10.6	5.5
Manganese	30.8	46.3	31.9	42.8	27.2	18.5
Mercury	0.12	0.22	0.18	0.34	0.24	0.16
Nickel	9.5	9.5	10.7	20.4	20.5	18.9
Selenium	2.9	2.4	1.9	5.0	4.3	2.4
Uranium	1.8	1.7	1.1	1.7	1.8	1.4
Number of Samples	54	80	194	119	219	73

Table 5.--Lateral distribution of potential air toxics within the Pittsburgh coal bed from Ohio, Pennsylvania, and West Virginia.

(Values are arithmetic means in parts-per-million on a whole coal basis.)

Element	Sample					
	1	2	3	4	5	6
Antimony	0.4	1.4	0.4	0.4	1.4	0.3
Arsenic	13.3	75.1	15.0	9.6	79.8	10.0
Beryllium	1.1	1.2	1.6	1.4	1.0	0.3
Cadmium	0.10	0.07	0.14	0.06	0.09	0.04
Chromium	14.4	9.3	10.1	10.3	9.2	10.2
Cobalt	2.8	3.1	11.8	2.7	4.9	1.7
Lead	3.6	3.7	1.5	3.8	6.9	1.0
Manganese	17.8	19.1	55.1	19.7	25.6	25.3
Mercury	0.10	0.22	0.60	0.16	0.28	0.22
Nickel	7.1	6.3	20.9	9.0	9.5	4.3
Selenium	1.5	3.4	3.0	0.9	1.7	1.0
Uranium	0.8	0.3	2.0	0.9	1.4	2.4

Table 6.--Variations of potential air toxics from the top to the bottom of a set of bench samples from the Pittsburgh coal bed in Ohio.

(Values are in parts-per-million on a whole coal basis. Total thickness of the bed is 52.5 inches.)

	Samples						
	top						bottom
Element	1	2	3	4	5	6	7
Antimony	0.6	0.2	0.2	0.2	0.3	0.3	0.4
Arsenic	10.4	12.6	4.9	6.3	8.2	31.9	12.8
Beryllium	3.0	1.5	0.8	0.7	1.6	1.3	3.4
Cadmium	0.10	0.09	0.03	0.05	0.08	0.08	0.09
Chromium	30.4	7.4	6.9	9.8	32.7	11.8	12.5
Cobalt	9.2	2.2	1.6	2.1	6.6	1.3	3.3
Lead	8.7	1.6	1.3	1.4	5.5	1.5	5.1
Manganese	12.6	10.3	8.8	7.34	24.8	8.4	13.7
Mercury	0.24	0.29	0.10	0.14	0.20	0.19	0.05
Nickel	16.6	5.8	2.9	4.7	21.3	5.9	13.7
Selenium	8.5	3.3	1.1	1.5	2.2	0.9	0.9
Uranium	2.0	0.3	0.3	0.4	1.3	0.3	0.6

coal quality database was designed to assess vertical and lateral variation of coal quality parameters and was not designed to determine the amount of a component per ton of coal. Therefore, the data are not weighted by bed thickness or heat value.

Modes of Occurrence of Trace Elements

The Coal Quality data base provides information on the concentration and vertical and lateral distribution of many coal quality parameters including the major-, minor-, and trace-elements. This information is especially useful for seeking coals with particular coal quality characteristics or for determining regional trends.

However, to anticipate the environmental impact, technological behavior, or byproduct potential of an element requires information on the element's modes of occurrence (chemical form) and textural relations. Currently, information on modes of occurrence is not included in the coal quality data base. The USGS has, however, conducted extensive investigations on the modes of occurrence and textural relations of the elements in coal. The results of these investigations have been published in numerous papers. See, for example: Zubovic (1966, 1976); Zubovic and others (1960); Finkelman (1981, 1993, in press); Finkelman and others (1990); Palmer and Filby (1983); Ruppert and others (1984).

Statistical Correlations of Coal Quality Parameters

One indirect method of deducing an element's mode of occurrence is to determine the correlation of the element with ash yield, sulfur, or other coal quality parameters. This can be a useful, but it also can be a potentially misleading procedure.

This is because in a geologic data base, such as the USGS's Coal Quality data base, correlation coefficients generally reflect a common source rather that a close chemical or physical affinity. For example, Cecil and others (1979) found petrographic evidence of extensive mobilization of many trace elements in the Upper Freeport coal bed. Because the Upper Freeport coal bed was a closed geochemical system for many elements, they retained their statistical correlations with ash yield and other parameters, despite these elements having changed their chemical form and distribution patterns. Finkelman (1981), based on research on the Gulf Coast lignites, also concluded that there was extensive remobilization of the elements despite strong statistical correlations between element concentrations and ash yield.

It is evident that caution must be exercised in interpreting results of statistical tests applied to the Coal Quality data base, or any other geochemical data base. Table 7 contains a list of strengths and potential weaknesses of the Coal Quality data base as well as cautions to those using the data base.

Table 7.--Strengths and Weaknesses of the USGS Coal Quality Data Base and Cautions for its Use

		STRENGTHS
*Large size	—	13,035 analyzed U.S. samples.
	—	All major coal basins and major coal producing beds are represented.
* Reliable data	—	High quality analytical procedures used, such as ASTM (1993) standards.
	—	State-of-the-art analytical procedures used to generate element analyses.
	—	Standardized sample collection and handling procedures.
* Comprehensive	—	136 parameters can be determined on each sample, including data on more than 75 chemical elements.
* Convenient	—	Easy public access
	—	Multimedia data dissemination
	—	Free to inexpensive
		Weaknesses
* Dated	—	Many samples collected and analyzed prior to 1982.
	—	In the immediate vicinity of many samples coal is now mined out or coal mining has ceased.
*Not geographically balanced	—	Only 113 samples from Illinois
	—	58 analyses from Idaho
	—	No clean coal data
	—	No mineralogical data
	—	No modes of occurrence information
* Data base is incomplete	—	Additional samples required to adequately characterize all major beds in all coal bearing areas of the country.
		Cautions
*Geologic/Exploration data base	—	Sample collection not geared to production.
	—	Some samples have high ash yields or high sulfur contents. Some samples are from coal beds that are too thin or too deep for mining or are from frontier areas.
	—	Partings > 10 cm eliminated.

*Some analytical procedures have changed with time.

*Samples do not have a uniform geographic distribution within coal basins for individual coal beds. Many samples were collected as opportunities presented, rather than collected as or where needed.

*Limited statistical evaluation of data.

*Samples collected by more than 20 different agencies with many individual collectors, not all of whom adhered strictly to the standards prescribed by the USGS.

Methods of Data Dissemination

Information from the Coal Quality data base can be obtained through several different formats and media. Data requested from the USGS Branch of Coal Geology can be obtained on cartridge tapes, 3.5" or 5.25" floppy disks, or by hardcopy. Output files from searches performed by USGS personnel can also be retrieved by outside users via anonymous file transfer protocol. At present, data can be output from Rbase as ASCII delimited, ASCII fixed, Lotus123 (.wks), Dbase (.dbf), DIF, and Multiplan (SLYK) files. The chemical data are stored on a CD-ROM (currently in a test mode: projected date of availability to the public is July 1994) and can be accessed via an accompanying search and retrieval program called GSSEARCH. Output files from the CD-ROM can be exported in formats usable in PC-based data base managers or spreadsheets. The data base should be available sometime in 1994 for searches on the NCRDS's SUN UNIX server via Internet using the INGRES relational data base manager.

Requests for information should reference the Freedom of Information Act and can be mailed or faxed to the Branch of Coal Geology. The mailing address is: U. S. Geological Survey, Attention: Linda Bragg, Mail Stop 956 National Center, Reston, VA 22092. The fax number is 703-648-6419. Phone requests should be followed by written requests. When more than one hour is required to complete a data search, costs to cover materials and the hourly wages of the employee will be charged.

The following persons should be able to provide assistance with data requests and interpretation of the resulting information:

Linda Bragg	703-648-6451
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Charles Oman	703-648-6452
Susan Tewalt	703-648-6437

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APPENDIX

Definitions of parameters in the
U.S. Geological Survey Coal Quality data base.

U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT 94-205

U.S. GEOLOGICAL SURVEY
COAL QUALITY (COALQUAL) DATABASE: VERSION 1.3

The COALQUAL database, a subset of the 13,035 samples contained in the NCRDS' (National Coal Resources Data System) USCHEM (US geoCHEMical) data base, contains coal quality data in which a complete record represents a coal sample with a possible total of 136 fields. Chemical data for the samples are presented in this data base on an AS-RECEIVED, WHOLE-COAL basis. In addition, the oxides are also shown as a percentage of the total ash on an ash basis. Some fields may not contain data and will be represented as NO DATA ENTERED in the text fields or NULL values in the numeric fields. In the .dbf file (dBase data file) on the CD-ROM, NULL values will be represented as negative zeros (-0) in the numeric fields. The files displayed on the screen or produced as output files by GSSEARCH will contain blanks in fields having no data.

Details of sampling methods and analytical procedures can be obtained from the cited references and are contained as viewable documents on this CD-ROM. These ASCII files can be printed to dot matrix or laser printers.

The following section provides a description of each data field in the COALQUAL database and an explanation of all codes that are used. The analytical method(s) is noted for each field of coal quality data.

The following list contains the number of significant figures for analytical methods, when known. The user is cautioned to utilize only the correct number of significant figures as noted below for any final results of calculations or summaries of values in the database. For American Society for Testing and Materials (ASTM) analytical methods (ASTM Annual Book of Standards, 1992) we list the precision differences for reproducibility, in lieu of the known number of significant figures. All ASTM data are reported to two decimal places unless otherwise noted.

ASTM Property	Comments
Gross Calorific Value	100 Btu/lb on a DRY basis (reported with no decimal places)
Proximate Analysis	
Moisture	0.3 percent for <5 percent moisture; 0.5 percent for > 5 percent moisture
Ash yield	0.3 percent no carbonates present 0.5 percent carbonates present; 1.0 percent coals with > 12 percent ash containing carbonates and pyrite
Volatile matter [based on rank]	
	anthracite 0.6 percent; semianthracite and bituminous 1.0 percent; subbituminous 1.4 percent; lignite and peat 2.0 percent
Fixed carbon	calculated by difference {100-volatile matter (dry, ash-free basis)}
Ultimate Analysis	
Total Sulfur	0.1 percent for <2 percent sulfur; 0.2 percent for > 2 percent sulfur; 0.05 percent for coke
Carbon	0.3 percent
Hydrogen	0.07 percent
Nitrogen	not yet available
Forms of sulfur	
Sulfate	0.04 percent by weight
Pyritic sulfur	95 percent confidence interval of multiple analyses
Organic sulfur	calculated by difference {total sulfur-pyritic sulfur-sulfate sulfur}
Grindability of coal by Hardgrove-Machine (Reported to 1 decimal place) 3 points	
Ash Fusion temperatures	Normally reported to the nearest 10 degrees Fahrenheit

THE USGS MAKES NO CLAIMS AS TO THE ACCURACY OF COAL RANK CALCULATED FROM PARAMETERS OF PROXIMATE AND ULTIMATE ANALYSES. CALCULATED RANK MAY BE HIGHER FOR SOME SAMPLES DUE TO AIR-DRYING OF SAMPLES BEFORE ANALYSES.

USGS ANALYTICAL METHODS SIGNIFICANT FIGURES: ALL USGS ANALYTICAL DATA ARE REPORTED TO TWO SIGNIFICANT FIGURES, EXCEPT FOR GSASH WHICH IS REPORTED TO 1 DECIMAL PLACE. ALL ELEMENTAL DATA ARE REPORTED IN PARTS-PER-MILLION (PPM). DATA FIELDS ARE LABELED BY THE TWO LETTER SYMBOL FOR THE ELEMENT AND HAVE A SUFFIX OF _E SUCH AS AS_E, WHICH REPRESENTS ELEMENTAL ARSENIC. SEE THE FOLLOWING TABLE FOR THE DEFINITIONS OF OTHER FIELDS IN THE DATA BASE AND THE MANNER IN WHICH THE DATA ARE REPORTED.

Query operations may be performed on nearly all fields; all significant fields have been indexed for GSSEARCH.

Qualified data are not included in the data base as published. Greater than values have been treated as the value. Less than values have been treated by multiplying the value by 0.7 (SEE CONNOR, 1976 in REFERENC.DOC) and dropping the qualifier. NULL values represent zero values which were qualified. Qualified zero values are obtained when a sample was not analyzed for an element, when the element had interference in its analysis, and when an element was not detected during an analysis. The percentage of qualified values for each element was calculated using the original as-received data base

(USCHEM). This percentage calculation did not include qualifiers which resulted in NULL values. See each element in TECHINFO.DOC or in the HELP files.

Data for elements having more than 25 percent qualified values (Au, Bi, Cd, Cl, Dy, Er, Gd, Ge, Ho, In, Ir, Nd, Os, Pd, Pr, Pt, Rb, Re, Rh, Ru, Sn, Te, Tl, and Tm) should not be used and elements with 10 to 25 percent qualified values should be used with EXTREME caution.

Column definitions

#	Name	## Type	###	Definition
#	COLUMN INDICATES ITEM NUMBER IN DATA BASE AND NAME			
##	COLUMN INDICATES TYPE OF DATA FIELD: TEXT IS A CHARACTER FIELD INTEGER IS AN INTEGER NUMERIC FIELD REAL IS A REAL NUMBER FIELD			
###	COLUMN INDICATES TEXT FIELD LENGTH			
1.	LABID	TEXT	1	Analysis Identification Number (Alphabetic)
2.	SAMPLENO	TEXT Note:	6	Analysis Identification Number (Alphabetic) The combination of LABID and SAMPLENO form a unique sample identification number
3.	STATE	TEXT	30	Name of State where sample was collected
4.	COUNTY	TEXT	30	Name of county in state (or borough name in Alaska) where sample was collected
5.	LATITUDE	INTEGER		Latitude coordinate for point source location of coal sample (degrees, minutes, and decimal seconds)
6.	NS	TEXT	1	Hemisphere of Latitude (N OR S)
7.	LONGITUD	INTEGER		Longitude coordinate for point source location of coal sample (degrees, minutes and decimal seconds)
8.	EW	TEXT	1	Hemisphere of Longitude (E OR W)
9.	CPROVINC	TEXT	40	Coal Province Name-See Wood and others (1983), US Geological Survey Circular 891, page 16
10.	CREGION	TEXT	48	Coal Region Name-See Wood and others (1983), US Geological Survey Circular 891, page 15
11.	CFIELD	TEXT	40	Coal Field Name-See Barnes, F. F., 1961, Coal fields of the United States--Sheet 2, Alaska: U.S. Geological Survey, scale 1:5,000,000 See Trumball, J. V. A., 1960, Coal fields of the United States--Sheet 1: U.S. Geological Survey, scale 1:5,000,000
12.	DISTRICT	TEXT	48	District Name--Depending on the state, this field may be mining districts, political divisions (such as townships or

				boroughs), or other subdivisions of the state
13.	CFORMATN	TEXT	40	Formation Name--Stratigraphic formation name specified by the collector of the sample, usually a state geologist; or if collected by USGS personnel (SEE Stratigraphic Nomenclature Databases for the United States, its possessions and territories)
14.	CGROUP	TEXT	40	Group Name--Stratigraphic group name specified by the collector of the sample, usually a state geologist; or if collected by USGS personnel (SEE Stratigraphic Nomenclature Databases for the United States, its possessions and territories)
15.	CBED	TEXT	40	Bed Name--Stratigraphic bed name specified by the collector of the sample, usually a state geologist; or if collected by USGS personnel (SEE Stratigraphic Nomenclature Databases for the United States, its possessions and territories)
16.	CMEMBER	TEXT	40	Member Name--Stratigraphic member name specified by the collector of the sample, usually a state geologist; or if collected by USGS personnel (SEE Stratigraphic Nomenclature Databases for the United States, its possessions and territories
17.	CZONE	TEXT	40	Relationship between non-coal material and the coal bed (e.g., parting, roof, floor--not a coal zone name)
18.	DEPTH	REAL		Depth from the surface of the earth to the top of the sample if the sample is part of a drill core. If samples are not drill cores, but samples are benched, then depth is a measure from the top of the uppermost bench to the top of the next sample in the benched series. (Depth is measured in inches)
19.	SAMPTHK	REAL		Thickness of the sample, measured in inches
20.	SYSTEM	TEXT	40	System designates a fundamental unit of the sample's geologic age (SEE Stratigraphic Nomenclature Databases for the United States, its possessions and territories)
21.	SER_EPOC	TEXT	40	Designates a fundamental unit of the sample's geologic age, either series or epoch (SEE Stratigraphic Nomenclature Databases for the United States, its possessions and territories)
22.	COMMENTS	TEXT	100	Used as a comment field to describe the mine name, the drill hole identified, or other miscellaneous information about the sample
23.	MAP	TEXT	40	Usually the topographic quadrangle map name and series. For some areas of the U.S. where there are no topographic maps, another type of map name may be used along with the scale of the map.

24.	COLLECTR	TEXT	60	The agency and name of the person collecting or submitting the sample
25.	POINTID	TEXT	160	The field number assigned by the collector or submitter of the sample. For composited samples, pointid contains a list of the LABID and SAMPLENO for all samples combined.
26.	SUBDATE	DATE		The date the sample was confirmed by the USGS analytical labs as having been submitted for analysis (methods of analyses are determined by this date). (MM/DD/YY)
27.	ESTRANK	TEXT	30	Estimated rank of coal (also includes lithology for coal-related rock samples, which are not included in the database and are not listed here). --See Barnes, F. F., 1961, Coal fields of the United States--Sheet 2, Alaska: U.S. Geological Survey Map, scale 1:5,000,000 --See Trumball, J. V. A., 1960, Coal fields of the United States--Sheet 1: U.S. Geological Survey Map, scale 1:5,000,000
		Note:.		THE USGS MAKES NO CLAIMS AS TO THE ACCURACY OF COAL RANK CALCULATED FROM PARAMETERS OF PROXIMATE AND ULTIMATE ANALYSES. WITH SOME SAMPLES CALCULATED RANK MAY BE HIGHER DUE TO AIR-DRYING OF SAMPLES BEFORE ANALYSES ANTHRACITE SEMI-ANTHRACITE BITUMINOUS SUBBITUMINOUS LIGNITE COAL
28.	LABCODE	INTEGER		Code for laboratory performing analyses 5 =U.S. Geological Survey (USGS) 15 =USBM and USGS 35 =State agency and USGS 65 =USGS and Geochemical Testing Co., Somerset, PA 75 =USGS and Dickinson Laboratories, Inc., El Paso, TX 765 =USGS, Dickinson Laboratories, Inc., and Geochemical Testing Co.
29.	SAMPTYPE	INTEGER		Sample type 1 =Channel 3 =Drill core 11 =Weathered channel
30.	ANALTYPE	INTEGER		Analysis type 1 =As-received
31.	VALREP	INTEGER		Values represent 1 =Single Sample (Most common) 2 =Average of more than one sample (composite)
			NOTE:	A composite sample may be made by either A) physically combining samples on the basis of their thicknesses

B) or, mathematically weighting data from individual samples on the basis of bed thickness.

4 =Composite samples for ASTM analyses and samples for individual USGS analyses

5 =Composite samples for USGS analyses and individual samples for ASTM analyses

20 =Upper split (incremental sample, not a bench)

21 =Lower split (incremental sample, not a bench)

22 =Middle split (incremental sample, not a bench)

DEFINITIONS:

A) Splits = Herein defined as incremental samples of beds separated by 1 foot or more of non-coal material

32.	BTU	REAL	Gross calorific value of the coal sample expressed in British Thermal Units (BTU/lb) as determined by ASTM method D-2015. There are no qualified non-zero values for BTU in USCHEM.
33.	ASHDEF	REAL	Ash Deformation temperature in degrees Fahrenheit as determined by ASTM method D1857 in reducing atmosphere. Approximately 12 percent of the non-zero values for ASHDEF in USCHEM are qualified.
. 34	ASHSOF	REAL	Ash Softening temperature in degrees Fahrenheit as determined by ASTM method D1857 in reducing atmosphere. Approximately 19 percent of the non-zero values for ASHSOF in USCHEM are qualified.
35.	ASHFLD	REAL	Ash Fluid temperature in degrees Fahrenheit as determined by ASTM method D1857- in reducing atmosphere. Approximately 23 percent of the non-zero values for ASHFLD in USCHEM are qualified.
36.	FRESWL	REAL	Free-Swelling index as determined by ASTM method D-720. There are no qualified non-zero values for FRESWL in USCHEM.
37.	MOISTR	REAL	Moisture value (as-received basis) in percent as determined by ASTM method D-3173. There are no qualified non-zero values for MOISTR in USCHEM.
38.	VOLMAT	REAL	Volatile matter value in percent as determined by ASTM method D-3175. There are no qualified non-zero values for VOLMAT in USCHEM.
39.	FIXEDC	REAL	Fixed Carbon value in percent as determined by ASTM method D-3172. There are no qualified non-zero values for FIXEDC in USCHEM.
40.	STDASH	REAL	Ash value in percent as determined by ASTM method D-3174 (ash obtained at 750 degrees C). There are no qualified non-zero values for STDASH in USCHEM.
41.	HYDRGN	REAL	Hydrogen value in percent as determined by ASTM method

			D-3178. There are no qualified non-zero values for HYDRGN in USCHEM.
42.	CARBON	REAL	Carbon value in percent as determined by ASTM method D-3178 in USGS or other labs (see LABCODE). There is one qualified non-zero value for CARBON in USCHEM.
43.	NITRGN	REAL	Nitrogen value in percent as determined by ASTM method D-3179. There are no qualified non-zero values for NITRGN in USCHEM.
44.	OXYGEN	REAL	Oxygen value in percent as determined by ASTM method D-3176. There are no qualified non-zero values for OXYGEN in USCHEM.
45.	SULFUR	REAL	Sulfur value in percent as determined by ASTM method D-3177 in USGS or other labs (see LABCODE). Less than 1 percent of the non-zero values for SULFUR in USCHEM are qualified.
46.	SLFATE	REAL	Sulfate value in percent as determined by ASTM method D-2492 in other labs or similar method in USGS labs (see LABCODE). Approximately 22 percent of the non-zero values for SLFATE in USCHEM are qualified.
47.	SLFPYR	REAL	Pyritic Sulfur value in percent as determined by ASTM method D-2492 in other labs or similar method in USGS labs (see LABCODE). Approximately 17 percent of the non-zero values for SLFPYR in USCHEM are qualified.
48.	SLFORG	REAL	Organic Sulfur value in percent as determined by ASTM method D-2492 in USGS or other labs (see LABCODE). Approximately 18 percent of the non-zero values for SLFORG in USCHEM are qualified.
49.	ADLOSS	REAL	Air-Dried loss value in percent as determined by ASTM method D-2013. Less than 1 percent of the non-zero values for ADLOSS in USCHEM are qualified.
50.	HGI	REAL	Hardgrove Grindability value as determined by ASTM method D-409. There are no qualified non-zero values for HGI in USCHEM.
51.	EQMOIS	REAL	Equilibrium moisture value in percent as determined by ASTM method D-1412. There are no qualified non-zero values for EQMOIS in USCHEM.
52.	GSASH	REAL	Ash value in percent as determined by USGS laboratories (ash obtained at 525 degrees C). There is one qualified non-zero value for GSASH in USCHEM.
53.	SIO2	REAL	Silicon dioxide (SiO_2) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from SI_E value in parts-per-million which was determined

			by the same method. There are no qualified non-zero values for SIO2 in USCHEM.
54.	AL2O3	REAL	Aluminum oxide (Al_2O_3) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from AL_E value in parts-per-million which was determined by the same method. There are no qualified non-zero values for AL2O3 in USCHEM.
55.	CAO	REAL	Calcium oxide (CaO) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from CA_E value in parts-per-million which was determined by the same method. There are no qualified non-zero values for CAO in USCHEM.
56.	MGO	REAL	Magnesium oxide (MgO) value in percent as determined on the coal ash by USGS laboratories using wet chemistry analysis (atomic absorption: ash obtained at 525 degrees C)--May be converted from MG_E value in parts-per-million or percent which was determined by the same method. Less than 1 percent of the non-zero values for MGO in USCHEM are qualified.
57.	MNO	REAL	Manganese oxide (MnO) value in percent. Converted from MN_E as determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) and later using wet chemistry analysis on the ash to analyze for Mn. Less than 1 percent of the non-zero values for MNO in USCHEM are qualified.
58.	NA2O	REAL	Sodium oxide (Na_2O) value in percent as determined on the coal ash by USGS laboratories using wet chemistry analysis (atomic absorption: ash obtained at 525 degrees C)--May be converted from NA_E value in parts-per-million or percent which was determined by the same method. Less than 1 percent of the non-zero values for NA2O in USCHEM are qualified.
59.	K2O	REAL	Potassium oxide (K_2O) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from K_E value in parts-per-million which was determined by the same method. Less than 1 percent of the non-zero values for K2O in USCHEM are qualified.
60.	FE2O3	REAL	Ferric oxide (Fe_2O_3) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from FE_E value in parts-per-million which was determined by the same method. Less than 1 percent of the non-zero values for FE2O3 in USCHEM are qualified.

61.	TIO2	REAL	Titanium oxide (TIO_2) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from TI_E value in parts-per-million which was determined by the same method. Less than 1 percent of the non-zero values for TIO2 in USCHEM are qualified.
62.	P2O5	REAL	Phosphorous pentoxide (P_2O_5) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from P (P_E) value in parts-per-million which was determined by the same method. Approximately 19 percent of the non-zero values for P2O5 in USCHEM are qualified.
63.	SO3	REAL	Sulfur trioxide (SO_3) value in percent as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from S_E value in parts-per-million which was determined by the same method. Approximately 1 percent of the non-zero values for SO3 in USCHEM are qualified.
64.	SI_E	REAL	Silicon (Si) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from SIO2 value in percent which was determined by the same method. There are no qualified non-zero values for SI_E in USCHEM.
65.	AL_E	REAL	Aluminum (Al) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from AL2O3 value in percent which was determined by the same method. There are no qualified non-zero values for AL_E in USCHEM.
66.	CA_E	REAL	Calcium (Ca) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from CAO value in percent which was determined by the same method. There are no qualified non-zero values for CA_E in USCHEM.
67.	MG_E	REAL	Magnesium (Mg) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using wet chemistry analysis (atomic absorption: ash obtained at 525 degrees C)--May be converted from MGO value in percent which was determined by the same method. Less than 1 percent of the non-zero values for MG_E in USCHEM are qualified.
68.	NA_E	REAL	Sodium (Na) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS

			laboratories using wet chemistry analysis (atomic absorption: ash obtained at 525 degrees C)--May be converted from NA2O value in percent which was determined by the same method. Less than 1 percent of the non-zero values for NA_E in USCHEM are qualified.
69.	K_E	REAL	Potassium (K) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from K2O value in percent which was determined by the same method. Less than 1 percent of the non-zero values for K_E in USCHEM are qualified.
70.	FE_E	REAL	Iron (Fe) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from FE2O3 value in percent which was determined by the same method. Less than 1 percent of the non-zero values for FE_E in USCHEM are qualified.
71.	TI_E	REAL	Titanium (Ti) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from TIO2 value in percent which was determined by the same method. Less than 1 percent of the non-zero values for TI_E in USCHEM are qualified.
72.	S_E	REAL	Sulfur (S) value in parts-per-million on whole-coal basis, converted from value as determined on coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from SO3 value in percent which was determined by the same method. Approximately 1 percent of the non-zero values for S_E in USCHEM are qualified. THIS IS NOT STANDARD ASTM SULFUR.
73.	AG_E	REAL	Silver (Ag) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 20 percent of the non-zero values for AG_E in USCHEM are qualified.
74.	AS_E	REAL	Arsenic (As) value in parts-per-million as determined on whole-coal by USGS laboratories using either wet chemistry analysis for samples analyzed in Denver (D for LABID) before 1976 or Instrumental Neutron Activation Analysis (INAA) for samples analyzed in Reston (W for LABID) and for samples analyzed after 1976 in Denver. Less than 1 percent of the non-zero values for AS_E in USCHEM are qualified.

75.	AU_E	REAL	Gold (Au) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of the non-zero values for AU_E in USCHEM are qualified.
76.	B_E	REAL	Boron (B) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 5 percent of the non-zero values for B_E in USCHEM are qualified.
77.	BA_E	REAL	Barium (Ba) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 0.5 percent of the non-zero values for BA_E in USCHEM are qualified.
78.	BE_E	REAL	Beryllium (Be) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 2 percent of the non-zero values for BE_E in USCHEM are qualified.
79.	BI_E	REAL	Bismuth (Bi) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 98 percent of the non-zero values for BI_E in USCHEM are qualified.
80.	BR_E	REAL	Bromine (Br) value in parts-per-million as determined on whole-coal by USGS laboratories for samples having a LABID=W using Instrumental Neutron Activation Analysis (INAA). Approximately 7 percent of the non-zero values for BR_E in USCHEM are qualified.
81.	CD_E	REAL	Cadmium (Cd) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using wet chemistry analysis (atomic absorption--ash obtained at 525 degrees C). Approximately 29 percent of the non-zero values for CD_E in USCHEM are qualified.
82.	CE_E	REAL	Cerium (Ce) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS

			laboratories using either semi-quantitative 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 10 percent of the non-zero values for CE_E in USCHEM are qualified.
83.	CL_E	REAL	Chlorine (Cl) value in parts-per-million as determined on whole-coal by USGS laboratories using X-ray fluorescence analysis. Approximately 29 percent of the non-zero values for CL_E in USCHEM are qualified.
84.	CO_E	REAL	Cobalt (Co) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either semi-quantitative 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D with SUBDATE less than or equal to 76/08/19 or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 or LABID = D and SUBDATE greater than 76/08/19 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 2 percent of the non-zero values for CO_E in USCHEM are qualified.
85.	CR_E	REAL	Chromium (Cr) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either semi-quantitative 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D with SUBDATE less than or equal to 76/08/19 or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 or LABID = D and SUBDATE greater than 76/08/19 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis. Approximately 1 percent of the non-zero values for CR_E in USCHEM are qualified.
86.	CS_E	REAL	Cesium (Cs) value in parts-per-million on whole coal basis, converted from value determined on coal ash by USGS laboratories using either semi-quantitative 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-

			coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 8 percent of the non-zero values for CS_E in USCHEM are qualified.
87.	CU_E	REAL	Copper (Cu) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using wet chemistry analysis (atomic absorption--ash obtained at 525 degrees C). Less than 1 percent of the non-zero values for CU_E in USCHEM are qualified.
88.	DY_E	REAL	Dysprosium (Dy) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 89 percent of the non-zero values for DY_E in USCHEM are qualified.
89.	ER_E	REAL	Erbium (Er) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 82 percent of the non-zero values for ER_E in USCHEM are qualified.
90.	EU_E	REAL	Europium (Eu) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 6 percent of the non-zero values for EU_E in USCHEM are qualified.
91.	F_E	REAL	Fluorine (F) value in parts-per-million as determined on whole-coal by USGS laboratories using wet chemistry analysis (ion-selective electrode). Approximately 7 percent of the non-zero values for F_E in USCHEM are qualified.
92.	GA_E	REAL	Gallium (Ga) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Less than 1 percent of the non-zero values for GA_E in USCHEM are qualified.
93.	GD_E	REAL	Gadolinium (Gd) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic

			analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 73 percent of the non-zero values for GD_E in USCHEM are qualified.
94.	GE_E	REAL	Germanium (Ge) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 26 percent of the non-zero values for GE_E in USCHEM are qualified.
95.	HF_E	REAL	Hafnium (Hf) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 10 percent of the non-zero values for HF_E in USCHEM are qualified.
96.	HG_E	REAL	Mercury (Hg) value in parts-per-million as determined on whole-coal by USGS laboratories using wet chemistry analysis (cold-vapor atomic absorption). Approximately 7 percent of the non-zero values for HG_E in USCHEM are qualified.
97.	HO_E	REAL	Holmium (Ho) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 93 percent of the non-zero values for HO_E in USCHEM are qualified.
98.	IN_E	REAL	Indium (In) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of the non-zero values for IN_E in USCHEM are qualified.
99.	IR_E	REAL	Iridium (Ir) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). One hundred percent of the non-zero values for IR_E in USCHEM are qualified.

100.	LA_E	REAL	Lanthanum (La) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 10 percent of the non-zero values for LA_E in USCHEM are qualified.
101.	LI_E	REAL	Lithium (Li) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using wet chemistry analysis (atomic absorption--ash obtained at 525 degrees C). Approximately 1 percent of the non-zero values for LI_E in USCHEM are qualified.
102.	LU_E	REAL	Lutetium (Lu) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 12 percent of the non-zero values for LU_E in USCHEM are qualified.
103.	MN_E	REAL	Manganese (Mn) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) and later using wet chemistry analysis (atomic absorption on the ash). Less than 1 percent of the non-zero values for MN_E in USCHEM are qualified.
104.	MO_E	REAL	Molybdenum (Mo) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 7 percent of the non-zero values for MO_E in USCHEM are qualified.
105.	NB_E	REAL	Niobium (Nb) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash

			obtained at 525 degrees C). Approximately 11 percent of the non-zero values for NB_E in USCHEM are qualified.
106.	ND_E	REAL	Neodymium (Nd) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 31 percent of the non-zero values for ND_E in USCHEM are qualified.
107.	NI_E	REAL	Nickel (Ni) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 1 percent of the non-zero values for NI_E in USCHEM are qualified.
108.	OS_E	REAL	Osmium (Os) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of the non-zero values for OS_E in USCHEM are qualified.
109.	P_E	REAL	Phosphorus (P) value in parts-per-million as determined on the coal ash by USGS laboratories using X-ray fluorescence analysis (ash obtained at 525 degrees C)--May be converted from P2O5 value in percent which was determined by the same method. Approximately 19 percent of the non-zero values for P_E in USCHEM are qualified.
110.	PB_E	REAL	Lead (Pb) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using wet chemistry analysis (atomic absorption—ash obtained at 525 degrees C). Approximately 9 percent of the non-zero values for PB_E in USCHEM are qualified.
111.	PD_E	REAL	Palladium (Pd) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of the non-zero values for PD_E in USCHEM are qualified.
112.	PR_E	REAL	Praseodymium (Pr) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 82 percent of the

			non-zero values for PR_E in USCHEM are qualified.
113.	PT_E	REAL	Platinum (Pt) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of the non-zero values for PT_E in USCHEM are qualified.
114.	RB_E	REAL	Rubidium (Rb) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 54 percent of the non-zero values for RB_E in USCHEM are qualified.
115.	RE_E	REAL	Rhenium (Re) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of the non-zero values for RE_E in USCHEM are qualified.
116.	RH_E	REAL	Rhodium (Rh) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of the non-zero values for RH_E in USCHEM are qualified.
117.	RU_E	REAL	Ruthenium (Ru) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 100 percent of non-zero values for RU_E in USCHEM are qualified.
118.	SB_E	REAL	Antimony (Sb) value in parts-per-million as determined on whole-coal by USGS laboratories using wet chemistry analysis (Rhodamine B) for with LABID = D and SUBDATE less than or equal to 76/08/19. Samples with LABID = D and subdate greater than 76/08/19 and samples with LABID = W were analyzed using Instrumental Neutron Activation Analysis (INAA). Approximately 5 percent of the non-zero values for SB_E in USCHEM are qualified.

119.	SC_E	REAL	Scandium (Sc) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 1 percent of the non-zero values for SC_E in USCHEM are qualified.
120.	SE_E	REAL	Selenium (Se) value in parts-per-million as determined on whole-coal basis by USGS laboratories using X-ray-fluorescence on all older samples with LABID = D and SUBDATE less than or equal to 78/01/05 and all samples with LABID = W and SUBDATE less than or equal to 75/06/01. Samples with LABID = D and SUBDATE greater than 78/01/05 and all samples with LABID = W and SUBDATE greater than 75/06/01 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 6 percent of the non-zero values for SE_E in USCHEM are qualified.
121.	SM_E	REAL	Samarium (Sm) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/07/01. Samples with LABID = W and SUBDATE greater than 75/07/01 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 8 percent of the non-zero values for SM_E in USCHEM are qualified.
122.	SN_E	REAL	Tin (Sn) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 50 percent of the non-zero values for SN_E in USCHEM are qualified.
123.	SR_E	REAL	Strontium (Sr) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Less than 1 percent of the non-zero values for SR_E in USCHEM are qualified.

124.	TA_E	REAL	Tantalum (Ta) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D. Samples with LABID = W were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 18 percent of the non-zero values for TA_E in USCHEM are qualified.
125.	TB_E	REAL	Terbium (Tb) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 12 percent of the non-zero values for TB_E in USCHEM are qualified.
126.	TE_E	REAL	Tellurium (Te) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 99 percent of the non-zero values for TE_E in USCHEM are qualified.
127.	TH_E	REAL	Thorium (Th) value in parts-per-million as determined on whole-coal basis by USGS laboratories using Delayed Neutron Analysis (DNA) for older samples and Instrumental Neutron Activation analysis (INAA). Approximately 2 percent of the non-zero values for TH_E in USCHEM are qualified.
128.	TL_E	REAL	Thallium (Tl) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 95 percent of the non-zero values for TL_E in USCHEM are qualified.
129.	TM_E	REAL	Thulium (Tm) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 99 percent of the non-zero values for TM_E in USCHEM are qualified.

130.	U_E	REAL	Uranium (U) value in parts-per-million as determined on whole-coal basis by USGS laboratories using Delayed Neutron Analysis (DNA). Approximately 6 percent of the non-zero values for U_E in USCHEM are qualified.
131.	V_E	REAL	Vanadium (V) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Less than 1 percent of the non-zero values for V_E in USCHEM are qualified.
132.	W_E	REAL	Tungsten (W) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D. Samples with LABID = W were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 21 percent of the non-zero values for W_E in USCHEM are qualified.
133.	Y_E	REAL	Yttrium (Y) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Approximately 1 percent of the non-zero values for Y_E in USCHEM are qualified.
134.	YB_E	REAL	Ytterbium (Yb) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C) for all samples with LABID = D or all samples with LABID = W and SUBDATE less than or equal to 75/05/27. Samples with LABID = W and SUBDATE greater than 75/05/27 were analyzed on a whole-coal basis using Instrumental Neutron Activation Analysis (INAA). Approximately 2 percent of the non-zero values for YB_E in USCHEM are qualified.
135.	ZN_E	REAL	Zinc (Zn) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using wet chemistry analysis (atomic absorption--ash obtained at 525 degrees C). Less than 1 percent of the non-zero values for ZN_E in USCHEM are qualified.
136.	ZR_E	REAL	Zirconium (Zr) value in parts-per-million on whole-coal basis, converted from value determined on coal ash by USGS laboratories using either 6-Step emission spectrographic analysis for older samples or automatic plate reading

computer-assisted emission spectrographic analysis (ash obtained at 525 degrees C). Less than 1 percent of the non-zero values for ZR_E in USCHEM are qualified.